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ABSTRACT

Learning technology standards are increasingly gaining importance in the field of Web-based teaching. At present, two standards dominating the market are taking shape. These are the AICC (Aviation Industry Computer Based Training Committee) standard of the AICC organization and the SCORM (Sharable Content Object Reference Model) standard of the ADL (Advanced Distributed Learning) initiative. At present, only the AICC standard can be certified; however, in the near future, the SCORM standard will be certifiable as well. Based on the AICC and LOM (Learning Object Metadata) metadata standards, the SCORM standard stands the chance to become the standard dominating the market. A number of restrictions are involved with the standards, however. This paper examines general deficiencies of the standards mentioned, as well as the problems resulting from their applications to learning management systems. (Author)

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A Critical Discussion of Standards for Web-based Learning

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Abstract: Learning technology standards are increasingly gaining in importance in the field of Web-based teaching. At present, two standards dominating the market are taking shape. These are the AICC standard of the AICC organization and the SCORM standard of the ADL initiative. Up to now, only the AICC standard can be certified. But in the near future the SCORM standard will be certifiable, too. Based on the AICC and LOM meta data standards, the SCORM standard stands the chance to become the standard dominating the market. A number of restrictions are involved with the mentioned standards, though. This article examines general deficiencies of the mentioned standards, as well as the problems resulting from their application to learning management systems.

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Introduction

Over the past few years several initiatives developed, at first in the USA, aiming at the standardization of computer based teaching components. This article focuses on the AICC standard of the AICC organization and the SCORM standard of the ADL initiative. Why are standards important for Web-based learning environments and technologies? Considering the increasing number of virtual learning environments, it is obvious that the same contents are processed several times for multimedia use because they cannot be found or used straight away. This is where standardization efforts start from.

Influential Factors on the Interface between WBT/LMS

LMSs offer tools which manage and generate different sorts of data. The term LMS can denominate simple course management systems as well as highly complex LMSs with extended functionalities. These additional functionalities include interfaces to other information systems as well as reports, registration, and online collaboration. (Hendricks, 2001, p.20) Web-based Trainings (WBTs) should work with any Learning Management System (LMS). For this to be possible, the exchange of data must work.

There are many authoring systems on the market to produce learning units with. The decision on a certain system often binds the vendor of learning content to that system. This is not surprising because some of the possibilities the individual systems offer differ considerably. Up to now, it is not possible to transport learning units between different authoring systems without any difficulties. Therefore, a future change of authoring systems correspondingly turns out to be difficult. This causes problems for developers of WBTs. The exchange of WBTs between different LMSs leads also to some difficulties. In this field as well has developed a multitude of systems in the meantime. But none of these systems has achieved a dominating position, yet. The selection is made on application-specific criteria. (Hagenhoff, 2001)

Requirements for Standardization

To facilitate the exchange of knowledge between different institutions, the content to be exchanged has to be standardized. The aim is to be able to use LMS components efficiently and independent of system environments, the authoring systems used, and further technical infrastructure.

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The most important influential factors on the effectivity and efficiency of learning technology, and thereby on Web-based elearning, are aspects of the reusability of the content, the interoperability/ portability of the content objects, the recombinability of content, methods and specifications, the recontextualization of the content in various contexts, the flexibility regarding the granularity of the content, the simplicity to use the standard and the efficiency of a standard. (Pawlowski, 2001, p.58).

AICC

Having developed from the US-American aviation industry, the industry-wide standardization committee AICC has more than ten years of experience in the field of computer based learning and today deals with the development of interoperable learning technologies. AICC's guidelines define standards, which permit LMSs and WBTs to exchange data. These guidelines are developed continuously. It is the purpose of the AICC standard, to facilitate the development of WBTs independent of a concrete LMS. With the help of structure files, a WBT conforming to AICC can quite easily be integrated in a leaning management system conforming to AICC. Lessons of a WBT are launched by the LMS. According to the AICC specifications, the LMS and the AICC compatible lessons must have common interfaces for data exchange. Thus, the LMS has the ability to start learning content as well as to track the learner's progress.

WBTs and LMS conforming to AICC can be certified. The certification is limited to a period of two years and has to be renewed thereafter. The following paragraphs show in detail which data is defined by the AICC standard and how the data exchange is realized.

Communication between LMS and WBT

When starting a lesson, the LMS sends static learner data (e.g. the name of the learner), dynamic data (produced during the previous learning session) as well as messages and comments from the tutor. Lessons completed or aborted by the user send data to the LMS. This data is utilized for the analysis of the learning progress.

Data Groups

The AICC standard defines the following 9 groups of data:

- *Core data:* Core data contain basic data of the learner, the learning session, and the learning success. (AICC, 2001, p.63)
- *Lesson data:* This is where individual information for the next start of the lesson is stored. This data is drawn up during a learning session and is stored and managed by the LMS. Among other things, this is data about where a learner has left a lesson. It facilitates the learner's return to the exact position of that lesson. (AICC, 2001, p.77) Furthermore, the learner's way through a lesson is recorded.
- *Core data of the vendor:* Vendor specific data, necessary for some lessons. (AICC, 2001, p.193)
- *Comments:* With help from the LMS, the tutor can send help texts to the learner. (AICC, 2001, p.79) The other way round, the learner can write comments about a lesson to the tutor. In doing so, the position the comment refers to is sent to the LMS. (AICC, 2001, p.193)
- *Evaluation:* During learning sessions data about learner performance and his or her objectives status can be ascertained. (AICC, 2001, p.81)
- *Objectives status:* Objectives can be given in each lesson. It is recorded, whether the learner has achieved the lesson's objectives or not. (AICC, 2001, p.85). In addition, the achieved score and the required time are recorded. (AICC, 2001, p.213)
- *Learning data:* This group of data supports the adjustment of a learning unit to the performance of the learner. Thus, a learner can be offered a starting point according to his or her knowledge level. Furthermore, data on the learner performance is transferred. (AICC, 2001, p.91f.)
- *Student Demographics:* With the personal data available to the LMS, learning content can be individualized, e.g. by selection of the language. (AICC, 2001, p.98)

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- *Student preferences*: This data group stores parameters chosen by the learner to adjust the learning environment. Among other things, this includes audio and video settings.

Course Structure and Level of Complexity

First of all, the definition of the course structure serves for the simple exchange of courses. The definition of the course structure stipulates the ways the learner can or must take through the learning unit. This information is stored in the structure files. The AICC standard defines four levels of complexity (1, 2, 3a, 3b). The levels show how complex a course is and which data the LMS requires. For level 1 information the AICC standard uses the six data groups core data, lesson data, comments, objectives status, learning data, and student preferences. While the evaluation data of level 1 refers to the lesson as a whole, the optional second level facilitates further, more detailed evaluation data on learner performance and behaviour. (AICC, 2001, p.137)

SCORM

The Advanced Distributed Learning Initiative (ADL) is financed by the US department of defense in cooperation with the White House Office of Science and Technology Policy and deals with the interoperability of learning courses. The initiative sees itself as an integrating approach and a coordinating institution. Coordinated by the ADL, the AICC, the IEEE (Institute of Electrical and Electronics Engineers), and the IMS (Instructional Management System Global Consortium, http://www.imsproject.org) have agreed on facilitating the cooperation of LMSs and WBTs of different vendors.

The ADL initiative mainly focuses on the design and development of sharable courseware objects. These shall be retrievable from a global information network in real time. (Fletcher, 2000) To achieve these goals, the ADL initiative formulated higher requirements for learning content like reusability, accessability, durability, and interoperability and, based on this, developed a reference model for sharable learning objects. (Dodds, 2001, p.1-3f.) This reference model, the Sharable Content Object Reference Model (SCORM), defines a Web-based model for the aggregation of learning content (content aggregation model) as well as a run-time environment for learning objects. The SCORM's purpose is to connect developing technologies and commercial as well as public implementations. (Dodds, 2001, p.1-4) SCORM focuses on key interfaces between learning content and different LMSs but is not specific about features and abilities of a certain LMS. (Dodds, 2001, p.1-31) An LMS must be able to track learner progress and to assess mastery of learning content. Among other things, this includes collecting learner profile information, delivery of content to the learner, tracking of key interactions and the performance within the content as well as determining the learner's next assignment.

The SCORM Run-time environment includes support for the communication with and the tracking of content in Web-based environments and is based on the run-time environment functionalities as defined in the AICC Guidelines for Interoperability. It provides mechanisms for a standardized learner tracking. The control flow regarding reusable and interoperable learning objects is managed externally by the LMS. But the LMS does not control the control flow within the learning objects. (Dodds, 2001, p.1-32)

SCORM Content Aggregation Model

The Content Aggregation Model supports the assembling of Sharable Content Objects (SCOs). It describes a nomenclature for learning content and references the IMS learning resource metadata information model, which for its part is based on the LOM specifications of the IEEE-LTSC (Learning Technology Standards Committee, http://www.ltsc.ieee.org). The Content Aggregation Model determines how learning content can be identified, described, assembled, and transferred from one LMS to another. In the SCORM Content Aggregation Model learning content consists of assets. Assets are electronic representations of media (e.g. text, pictures, sound, and websites). An asset can be tagged to a metadata document in an XML format, which supports the locating of assets and their retrieval from online-repositories. (Dodds, 2001, p.2-3)

A Sharable Content Object (SCO) represents one or more assets which use the SCORM run-time environment to communicate with different LMSs. An SCO represents the lowest level of content granularity which can be tracked by an LMS. An SCO should be independent of learning context to be reusable in different learning situations. Moreover, several SCOs can be assembled to form learning or exercise units on a superordinate level. To make a potential reuse practicable, SCOs should be small units. They can be the basis for sharable content repositories which facilitate their exchange. Only an LMS may launch an SCO, an SCO must not launch other SCOs. (Dodds, 2001, p.2-4) With the mechanism of content aggregation, content objects (SCOs, assets) can be assembled to form bigger learning units (e.g. course, chapter). This mechanism determines the structure and performance as well as the sequence of the individual SCOs. (Dodds, 2001, p.2-6)

The mechanism of content aggregation supports the reuse of learning content und reduces the dependency of a course on a particular LMS. The structuring mechanism of content aggregation is derived from the computer managed instruction (CMI) specifications of the AICC. (Dodds, 2001, p.2-102) According to the content aggregation description, the LMS interprets respectively processes the rules for navigation defined within the aggregation of SCOs. (Dodds, 2001, p.2-102) The navigation for the SCOs is determined by the structuring mechanism of the content aggregation and is not part of an SCO. It is the LMS which is responsible for launching the SCOs in the defined sequence in run-time. This is important because content would not be reusable, if it contained course context-specific information. (Dodds, 2001, p.2-7)

Metadata in the SCORM

The metadata of the SCORM is based on the IEEE-LTSC LOM standard and on the IMS metadata specifications. (Dodds, 2001, p.2-10) There are nine categories of metadata elements altogether: general metadata, lifecycle metadata, meta-metadata, technical metadata, pedagogical metadata, metadata concerning rights, relational metadata, metadata on annotations and classifications. For the SCORM, a number of metadata elements were marked to be binding. In addition, further specific metadata elements can be stipulated. With the help of the metadata elements, the learning objects to be managed can be described in a standardized way. (Dodds, 2001, p.2-11) Guidelines concerning the use of metadata should be defined based on the specific requirements of the respective organisation.

Analysis of AICC and SCORM

Fundamental objectives of the presented standards are the easy portability of learning content from one LMS to another as well as the reusability of learning objects. The easy portability of WBTs creates an additional benefit for vendors of learning content and LMSs because the high costs for portation are reduced. WBTs can exchange data with the LMS via standardized interfaces. Above all, the metadata model of the LOM standard integrated in the SCORM supports the retrieval of learning objects in varying constellations. AICC denominates the smallest unit which can be administered by an LMS as an assignable unit (AU). This corresponds with the SCORM's Sharable Content Object (SCO). In the following, AUs and SCOs will be summarized under the term learning module. If common characteristics of the AICC and the SCORM standards are adressed, the general term "standard" is used and if a distinction between AICC and SCORM is necessary it is made explicit.

Potentials of AICC and SCORM

An important advantage of standard conforming WBTs is that they are basically interoperable with all standard conforming LMSs. In addition, they can exchange important user data, metadata on learning units, and a variety of interaction data (e.g. choice of path, current position in the learning unit, comments/annotations, duration, scores) in a standardized way with standard conforming LMSs. The basic metadata of a standard conforming learning unit is transferred to the LMS in the form of files when the learning unit is delivered, so that this metadata does not has to be fed to the LMS separately.

When using standard conforming learning units, an LMS can offer learners a learning account. Learner scores can be managed course comprehensively in a standardized way via this learning account. Though with AICC the possibilities the learning account offers are limited because not the complete test results but only results concerning single basic questions/exercises can be transferred to the LMS. Furthermore, the learner can take a look at a table of his or her learning status relating to single learning modules at any time. Learning module-specific comments a lecturer has left for a certain learner can be displayed when the learning module is started. The administration of the current position in an individual learning module can be done by the LMS, so that this information can be transferred when the learning module is launched. Annotations/comments transferred from the learning modules to the LMS can be managed by the LMS and be presented to the lecturer in a well-structured form. For the AICC standard must be observed, that student annotations can be transferred to the LMS, but the AU cannot request them from the LMS again later. The diverse data, which according to AICC/SCORM can be transferred to the LMS facilitates the comfortable supervision of the learning progress. The LMS could offer aggregated representations of test results and which learning modules have already been worked on by how many learners. Learning histories of the learners could be managed. Tracking data, transferred from the learning modules to the LMS, could be presented to the tutors in different views, so that they receive valuable indications concerning the further design of content. A long time on average spent on certain content pages could indicate that the content has to be processed better. Again, a low number of accesses on certain pages could indicate a lack of interest in the content.

Difficulties with AICC/SCORM conforming LMSs

The statements above basically show which potentials are connected with the use of standard conforming LMSs. But AICC and SCORM do not determine the use or processing of data transferred from learning modules to the LMS. In an extreme case it is possible that an LMS receives interaction data from a learning module but does not store it. This means that for the decision on a certain LMS it is not sufficient to see that the LMS is conforming to SCORM or certified by the AICC. It should be exactly analyzed how the AICC/SCORM standards have been implemented in the LMS and what the resulting possibilities for learners and lecturers are. AICC certified or SCORM conforming LMSs, which only provide minimal information for the learner (e.g. number of launches of the learning module, duration of learning with a learning module) for standard conforming learning modules and do not support the lecturer with evaluation data at all, fulfil the formal label of being AICC certified or conforming to the SCORM but by far do not use all the possibilities these standards do offer. Astonishingly, these statements are not as trivial as they may seem at first glance. Even some LMS market leaders use the possibilities offered by the AICC/SCORM standards only insufficiently.

Deficits of the AICC and the SCORM

In addition, there seems to exist a conflict between the principle of reusing learning modules and the classic web paradigm of using links to show relations between content. Neither in the AICC nor in the SCORM it is possible to realize hyperlinks from one learning module to another. The reason given for that is that it otherwise would not be possible to realize the principle of reusing learning modules. At the same time it is advised to produce as small learning modules as possible. Thus, referential links are only possible locally within the learning module and to external websites. Structural hyperlinks, however, are managed by the LMS. Each learning module has to be explicitly started by the learner via a menu on the LMS. Even an explicit textual reference within a learning module, referring to another part in another learning module, would not be advisable because it would also contradict the principle of reuse. In our opinion, and in contrast with the argumentation of the AICC and the SCORM, these standards could be extended in the way that at least a partial referential linking even between learning modules is possible. During the combination of learning units invalid learning module comprehensive hyperlinks and further referential text parts would have to be automatically recognized and filtered, though.

Theoretically it is possible to develop WBTs conforming to the AICC/SCORM consisting of merely one learning module. In this case, any number of hyperlinks can be integrated and WBTs can be developed, which support explorative learning. Indeed many developers follow this path currently. The described

variant limits the possibilities for reuse provided by the AICC/SCORM, though, and many of AICC/SCORM's possibilities remain unused. The LMS would receive and manage only some basic metadata (course name, course developer, etc.) and annotations/comments (unit-specific) as well as path information. The LMS does not have any information about the course structure and the administration concerning the learning status in learning modules is inapplicable. At least the authentification mechanism can be realized through the AICC/SCORM standards.

The previously put forward demand to extend the AICC/SCORM standards is important because the current limitations of the AICC/SCORM lead to standard conforming WBTs either not being able to make full use of the possibilities of the web paradigm or the AICC/SCORM. If the AICC/SCORM standards were extended appropriately, the objective of reusability could be supported better, the various advantages of the AICC/SCORM standards could be reached, and with the technique of referential linking, high-quality and learning module comprehensive functionalities could be integrated in the WBTs to better support the learning processes.

Conclusion

This article has explained the potential benefit of standards in the field of learning technology by example of the AICC and the SCORM. The main advantages are in the field of portability of learning content, the standardized communication interface between the LMS and CBTs/WBTs as well as in supporting the reusability of learning objects. A wealth of possibilities for support connected with the standards on the part of the LMS were shown clearly. But the article has also shown the basic difficulties of standards and the weaknesses of LMSs concerning the full use of the possibilities connected with standards. The effort of standardization should not too rashly be viewed negatively. The development of standards is a continous process. But in the framework of further developments, the criticized aspects mentioned above should be taken into consideration.

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